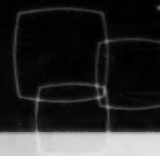




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**RECENT DOCTORAL GRADUATES IN CANADA AND THE U.S.A:  
INDICATORS FROM THE CANADIAN AND U.S. SURVEYS  
OF EARNED DOCTORATES**

Daniel Boothby, Industry Canada

Working Paper 2008-11

Canada

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### **Abstract**

This paper develops indicators on the doctoral programs of recent doctoral graduates in Canada and the U.S. using the Canadian and U.S. 2004 Surveys of Earned Doctorates and attempts to provide an interpretation of these indicators in the framework of the North American market for doctoral degree holders.

*Key words: advanced education, international mobility, field of study*

### **Résumé**

L'étude élabore des indicateurs portant sur les programmes de doctorat dont sont issus les récents diplômés au Canada et aux É.-U. en utilisant les enquêtes canadienne et américaine sur les doctorats obtenus en 2004 et tente d'interpréter ces indicateurs dans le cadre du marché nord-américain des titulaires de doctorat.

*Mots clés : enseignement postsecondaire, mobilité internationale, domaine d'étude*



The U.S. has conducted a Survey of Earned Doctorates (SED-US) annually since 1958. In 2003, Canada carried out a demonstration project for a Survey of Earned Doctorates at two universities, the University of Toronto and the Université de Montréal. In 2004, Canada carried out its first annual Survey of Earned Doctorates (SED-C). Both SED-US and SED-C are intended to survey all recipients of doctorates granted by universities in their respective countries in the period July 1-June 30 (so that the 2004 SEDs cover degrees granted between July 1, 2003 and June 30, 2004). The SED-C asks the same questions as the SED-U.S. questionnaire (as well as some additional items).

Despite the fact that SED-C was intended to facilitate reporting comparable indicators on doctoral careers for Canada and the U.S., little has been done along these lines. Auriol (2006, pp.7-8) does include three indicators from SED-US and SED-C. The purpose of this paper, then, is to use the 2004 SED-US and SED-C to develop and present indicators on doctoral studies and plans following graduation for doctorate recipients in the U.S. and Canada. Considerable emphasis is placed on the role of foreign students and on mobility—both to Canada and the U.S. for doctoral studies and from Canada and the U.S. once the doctorate is received.

The indicators reported are based on published data from the 2004 SED-US (Hoffer et al, 2005), published data from the 2004 SED-C (Gluszynski and Peters, 2005, Statistics Canada, 2005) and special tabulations from the 2004 SED-US that were very generously provided by Ms. Joan Burrelli of the National Science Foundation. Occasional use is also made of unpublished special tabulations from Canadian administrative data.

The plan of the paper is as follows. We first examine indicators that refer to numbers of doctoral recipients in Canada and the U.S., without regard to field of study. We then consider indicators as to the number of doctoral recipients by field of study. The next section of the paper takes up indicators of doctoral recipients' post-graduation plans, both as to their activities and their location. The final section attempts to arrive at an overall view of the production of doctorates in Canada and the U.S. and the implications for science and technology, and for innovation more broadly, in these two countries.

A companion paper concerns the labour market for doctoral degree holders in Canada and the U.S. Its conclusions are used in the final section.

### **Aggregate indicators**

From July 1, 2003 to June 30, 2004, Statistics Canada (2005) estimates that Canadian universities awarded approximately 3,600 earned doctorates. Over the same period, American universities awarded 40,710 earned doctorates. (NORC, 2005).

Of doctorates awarded in the two countries in 2003-2004, 8% were awarded by Canadian universities, and 92% were awarded by universities in the U.S. As of July 1, 2004, the Canadian population was 9.6% of the sum of the Canadian and U.S. population. In the 30-34 year old age group that one might think a typical age for completing a doctorate,

the Canadian population 30-34 years old was also 9.6% of the combined populations. Thus Canada is under-represented in the combined output of doctoral degrees.

### Quality

The quality of doctoral training, as well as the number of doctorates granted, is an important dimension in an assessment of the resulting input into national innovation systems. A rough indicator of the quality of doctoral degrees is furnished by the ranking of the degree-granting university in international assessments. The rankings used here are those produced by the Shanghai Jiao Tong University.<sup>1</sup> There is of course no claim made that every doctorate granted in every program at the top-ranked university in North America (Harvard University) is of higher quality than every doctorate granted in the corresponding program at the nineteenth-ranked university in North America (University of Toronto).<sup>2</sup>

The list of the twenty highest ranked universities in the U.S. is included in the Appendix. A striking aspect of this list is the dominance of the top ten by private universities. There is only one publicly funded university in the top ten (University of California Berkeley). There are seven publicly funded universities in the second ten. The University of Toronto, which is publicly funded, ranks seventh among publicly funded universities in North America, nineteenth among universities in North America, and twenty-fourth overall. (Twenty of the top 25 universities in the ranking are in North America; three are in the United Kingdom; and two are in Japan).

The twenty highest ranked universities in the U.S. awarded 8,732 doctorates in 2003-2004, 21% of doctorates awarded by universities in the U.S. in this year. The University of Toronto awards about 550 doctorates each year, about 5% of doctorates from highly ranked universities in North America. The nine highest ranked U.S. publicly funded universities awarded 4278 doctorates in 2003-2004, so that the University of Toronto awarded approximately 11% of the doctorates awarded by the ten highest ranked publicly funded universities in North America. On the basis of this admittedly crude quality measure, Canadian universities are under-represented in doctorate awards in "top twenty" North American universities, but are over-represented in doctorate awards in the "top ten" publicly funded universities.

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<sup>1</sup> <http://ed.sjtu.edu.cn/ranking2006.htm>

<sup>2</sup> Rankings of universities are controversial. In a recent review of rankings Usher and Savino (2007, p.30) find that "In those instances where one can use multiple ranking schemes to look at the relative scores of institutions in a single country, we find that certain institutions invariably rise to the top...Despite the very different weighting and aggregation schemes used by domestic and international league tables, these institutions manage to consistently monopolize the top spots". (The authors (p.31) reject the interpretation that these schemes are all measuring a common latent variable—quality—and instead attribute this consistency of outcomes to "dark matter" exerting a gravitational pull on all ranking schemes"). Usher and Savino also provide (p.29) a list of weights for various inputs to the different rankings. Shanghai Jiao Tung's ranking places the heaviest weight (90%) on research outputs; the other 10% is for learning outputs. This would seem an appropriate scheme for rating PhD programs.

### Citizenship

Not all of the doctorates awarded in either country were awarded to citizens of that country. (Table 1) In the U.S., U.S. citizens were 67% of doctorate recipients in 2003-2004, non-citizens with permanent resident status were 4%; and 29% were non-citizens in the U.S. on temporary visas. In Canada, 82% of doctorate recipients were Canadian citizens; 7% were non-citizens with permanent resident status in Canada; and 11% were non-citizens in Canada on temporary visas. Non-citizens are clearly a much smaller proportion of the recipients of doctorates in Canada than in the U.S.<sup>3</sup>

Table 1. Citizenship status of doctorate recipients, Canada and the U.S., 2003-2004

	Canada	U.S.
Citizen	82%	67%
Non-citizen, permanent resident	7%	4%
Non-citizen, temporary visa	11%	29%

The information in Table 1 allows us to compute doctoral graduation rates for Canadian and U.S. citizens. Approximately 2,950 Canadian citizens received doctorates from Canadian universities in 2003-2004. This yields a doctoral graduation rate of .7%.<sup>4</sup> In 2003-2004, 601 Canadian citizens received doctorates from universities in the U.S., approximately 17% of Canadians receiving doctorates in this year. If we include these Canadian citizens, the Canadian citizen graduation rate increases to .8%. For U.S. citizens, the graduation rate is .6%.<sup>5</sup> Doctoral graduation rates are thus higher for Canadian citizens than for U.S. citizens.

The figures cited in the preceding paragraph indicate that approximately 17% of doctoral degrees acquired by Canadian citizens in 2004 in the U.S. or Canada were acquired in the U.S. By way of comparison, one might note that while universities in the People's Republic of China (China) granted 18,806 doctorates in 2003 (Weiguo and Zhaohui, undated) U.S. universities granted 2,784 doctorates to citizens of China in this year. U.S. universities thus award 13% of the doctorates awarded to citizens of China by universities in one of the two countries (on the assumption that almost all doctorates awarded by universities in China are awarded to citizens of China). Despite much greater distance and barriers of language, this is very close to the 17% figure for Canada. Based on the 2004 SED-C, it is a reasonable estimate that 100 Chinese citizens received doctorates from Canadian universities in 2003. Canadian universities thus awarded less than 4% of doctorates awarded to citizens of China by universities in Canada or the U.S.,

<sup>3</sup> The comparison may be somewhat misleading, because 23% of doctoral graduates from Canadian universities came to Canada on a student or temporary visa when they first registered in their doctoral program. Thus approximately 12% of Canadian doctoral graduates entered on temporary visas, but subsequently acquired permanent resident and/or citizenship status. SED-U.S. does not collect information that would allow us to determine how many doctoral recipients in the U.S. with citizenship or permanent resident status originally entered on temporary visas.

<sup>4</sup> These graduation rates are computed as (doctorates 2003-2004/population 30-34 years in 2004) x 5.

<sup>5</sup> The weighted count of 100 U.S. citizens receiving doctorates from Canadian universities is a negligible proportion of the total doctorates received by U.S. citizens from universities in Canada and the U.S.

despite awarding 8% of all doctorates in the two countries. This is further evidence of the greater attractiveness of doctoral studies in the U.S. than in Canada to non-citizens, although both are North American countries with high quality English-language universities.

Table 2 shows the five leading countries of foreign citizenship for doctorate recipients in Canada and the U.S. In the U.S., the four leading countries of foreign citizenship are Asian: the People's Republic of China, Korea, India and the Republic of China. Together these four countries account for almost half of the doctorates received by non-citizens in the U.S. Canada occupies the fifth position. In Canada, U.S. citizenship is the leading foreign citizenship among doctorate holders; and the only Asian country in the top five of foreign citizenship is the Republic of China, followed by two European countries (France and the U.K.) and Iran.

Table 2. Top five countries of foreign citizenship, doctorate recipients, Canada and the U.S., 2003-2004

Countries as percentage of foreign citizenships among doctorate recipients in:			
Canada		U.S.	
U.S.	10.6	People's Republic of China	24.7
People's Republic of China	10.3	Korea (RoK and DPRoK)	11.1
France	8.2	India	7.7
United Kingdom	6.9	Republic of China	5.4
Iran	4.8	Canada	4.6

Taken together, Tables 1 and 2 indicate that Canada has proportionately fewer foreign citizens among doctoral recipients than the U.S., that foreign citizen doctoral recipients are much less concentrated in the five leading countries in Canada, and that Canada has not attracted citizens of the Chinas, India and the Koreas to doctoral studies in the same proportion as the U.S.

We noted above that, based on a world universities ranking, the twenty highest-ranked universities in the U.S. granted 21% of the doctorates awarded by U.S. universities in 2004. Table 3 shows the percentage of 2003-2004 PhD recipients from the twenty highest-ranked universities for U.S. citizens and for citizens of each of the five countries whose citizens received the greatest number of doctorates from U.S. universities.

The percentage of doctorate recipients from the top-ranked universities is 20% for U.S. citizens, at this level or slightly above for four of the five leading foreign citizenships, and much higher at 33% for Canadian citizens. We would interpret the higher percentage of Canadian citizens at top-ranked universities as a result of the availability of one "top twenty" university and of a number of other high-quality PhD programs in Canada.<sup>6</sup> In our view, this means that Canadian citizens are likely to study in Canada unless they are

<sup>6</sup> The 100 world-highest ranked-universities include three other Canadian universities (University of British Columbia, McGill University, McMaster University).

admitted to the very best of U.S. universities. While the twenty highest ranked U.S. universities granted doctorates to 202 Canadian citizens in 2003-2004, the University of Toronto (the one "top twenty" university in Canada) granted doctorates to more than 400 Canadian citizens in 2003-2004.<sup>7</sup> Canadians would appear to be more likely to pursue their doctoral studies in a university in the U.S. if it is a "top twenty" university; otherwise they may tend to remain in Canada for their doctoral program.

Table 3. Percentage of doctorate recipients from twenty highest-ranked U.S. universities by citizenship, 2003-2004

Country of citizenship	Percentage of doctorates from 20 top-ranked universities
U.S.	20
People's Republic of China	21
Korea (RoK and DPRoK)	20
India	20
Republic of China	23
Canada	33
All other	22
Total	21

### Field of study

We turn now to an examination of the fields of study in which Canadian and American universities award doctorates to their own and to foreign residents<sup>8</sup>. Table 4 gives the field of study distribution of Canadian and foreign doctorate recipients in Canada and citizen and non-citizen doctorate recipients in the U.S. in 2003-2004. In both countries, foreign doctoral graduates are heavily concentrated in engineering and the physical sciences, relative to doctoral graduates who are citizens or permanent residents. In the U.S., foreign graduates received 60% of doctorates awarded in engineering and 44% of doctorates in the physical sciences. The corresponding percentages for Canada are 46% in engineering and 37% in physical sciences. In both countries, foreign doctoral graduates are under-represented in the social sciences and in humanities relative to citizens and permanent residents. In the U.S. foreign doctoral graduates are also under-represented in other (which is predominantly doctorates in education). In Canada, foreign doctoral graduates are also under-represented in the life sciences.

<sup>7</sup> Our estimate. The University of Toronto grants more than 500 doctorates a year and at least 80% of these are to Canadian citizens.

<sup>8</sup> The published data from SED-C that we use are for "foreign students" that is doctorate recipients who were visa or foreign students when they first registered in their doctoral program. (Those who are not "foreign students" were either Canadian citizens or permanent residents). The tables from SED-US are either for foreign citizens on temporary visas (others are U.S. citizens or permanent residents) or all foreign citizens (others are U.S. citizens), both as of the award of the doctorate.

Table 4. Field of study distribution of Canadian and foreign doctorate recipients in Canada and citizen and permanent resident and temporary visa doctorate recipients in the U.S., 2003-2004

	Canada			U.S.A.		
	Canadian	Foreign*	% Foreign	U.S.	Foreign**	% Foreign
Life Sciences	30	22	18	22	20	28
Engineering	9	27	46	8	29	60
Physical Sciences	13	25	37	12	22	44
Social Sciences	21	7	9	18	10	19
Humanities	15	9	16	16	7	16
Other	12	10	20	25	12	17
All	100	100	23	100	100	29

\* Visa or foreign student when first registered in doctoral program.

\*\* Not a U.S. citizen or permanent resident when doctorate received.

Table 5 gives the field of study distribution for doctoral graduates from U.S. universities by citizenship for U.S. citizens, those from the top five countries of foreign citizenship and those from all other countries. The field of study distribution for Canadian citizens who receive doctorates in the U.S. is broadly similar to that of Canadian citizens who receive doctorates in Canada and to that of U.S. citizen recipients (except for the lower percentage of doctorates in other fields of study, due to a much lower percentage of doctorates in Education).

The field of study distribution for citizens of other countries is markedly different. More than a third of doctoral recipients who are citizens of the People's Republic of China (China), India and Korea studied engineering. The combined percentage of Life Sciences, Engineering and Physical Sciences is 88% for the People's Republic of China, 82% for India, 64% for Korea and 61% for the Republic of China (Taiwan), but only 50% for Canada and 41% for the U.S.

Weiguo's and Zhaohui's (undated) paper allows us to compare the distribution for citizens of the People's Republic of China in Table 5 with the distribution by field of study of doctorates awarded by universities in the People's Republic in 1999-2003. They show 38% of doctoral degrees in Engineering, 22% in Sciences, and 4% in Agriculture and 15% in Medicine (both of which would be included in Life Sciences in Table 5). The percentage of doctoral degrees in Engineering is exactly the same as in Table 5; the combined percentage of Sciences, Agriculture and Medicine (42%) is somewhat below the combined 50% share of Physical Sciences and Life Sciences in Table 5. For the People's Republic of China as for Canada, the field of study shares of doctorates awarded to citizens of these countries by U.S. universities are similar to the shares awarded by universities in the country.

Table 5. Field of study distribution by citizenship for doctorates awarded by universities in the U.S., 2003-2004

Citizenship	Field of Study					
	Life Sciences	Engineering	Physical Sciences	Social Sciences	Humanities	Other
U.S.	21	8	11	19	15	26
China	23	38	27	4	2	6
India	26	36	19	8	3	8
Korea	14	35	15	10	10	17
Taiwan	18	21	14	8	11	28
Canada	24	10	16	18	18	15
All other	19	20	22	14	12	13

### Engineering

The Engineering field of study seems to merit further attention—it is a field of study in Science and Technology; it attracts a very large percentage of doctoral recipients from Asian countries; and it attracts a low percentage of doctoral recipients from Canada and the U.S. Table 4 shows that 60% of doctoral degrees awarded in Engineering in the U.S. are awarded to foreign citizens on temporary visas. In fact, citizens of the People's Republic of China account for 21% of doctorates in Engineering awarded in the U.S.; and the combined total for India, Korea and the Republic of China is a further 18% of doctorates in Engineering in the U.S.

The Shanghai Jiao Tong University group not only ranks world universities overall, it also ranks world universities by broad field of study.<sup>9</sup> One of their sets of rankings is for Engineering/Technology and Computer Science.<sup>10</sup> As in the overall rankings, universities in North America dominate the top positions. Once again, the University of Toronto (ranked 19<sup>th</sup> overall and 17<sup>th</sup> in North America) is the only Canadian in the twenty highest-ranked North American universities. A striking difference with the overall rankings is that publicly funded North American universities fare much better in the Engineering rankings. Publicly funded universities account for seven of the world top ten positions, while private universities account for nine of ten top ten positions in the overall rankings.

Table 6 gives the percentage of doctorates in Engineering awarded by the twenty highest-ranked universities for U.S. citizens, for citizens of each of the five most prevalent foreign citizenships and for citizens of all other countries. Doctorate awards in Engineering are far more concentrated in the twenty highest-ranked universities in Engineering (40%) than all doctorates in the twenty highest ranked universities overall (21%). The "top twenty" U.S. universities in Engineering are slightly over-represented in Engineering doctorates awarded to U.S. citizens, strongly over-represented in doctorates

<sup>9</sup> <http://ed.sjtu.edu.cn/ARWU-FIELD2007/ENG.htm>

<sup>10</sup> Computer Science and Mathematics are included in the Physical Sciences group in both the SED-US and SED-C.

awarded to citizens of Korea, the Republic of China and Canada, and under-represented in doctorates awarded to citizens of India and the People's Republic of China.

Table 6. Percentage of doctorate recipients in Engineering from twenty highest-ranked U.S. universities in Engineering by citizenship, 2003-2004

Country of citizenship	Percentage of doctorates from 20 top-ranked universities
U.S.	44
People's Republic of China	30
Korea (RoK and DPRoK)	51
India	37
Republic of China	54
Canada	59
All other	37
Total	40

As we did for the overall rankings, we would contribute Canada's over-representation in the Engineering "top twenty" to the availability of high quality Engineering programs in Canada, so that Canadians leave Canada only for programs of the highest quality. As noted, the University of Toronto is ranked 17<sup>th</sup> in the North America and 19<sup>th</sup> in the world. There are four other Canadian universities in the "top 100" (McGill University, the University of Waterloo, the University of British Columbia and the Université de Montréal).

Only a small number of doctorates are awarded in Engineering by the top-ranked Canadian universities. In 2002-2003, the University of Toronto awarded approximately 70 doctorates in Engineering. If (as in Table 4) almost half of these were awarded to foreign students, about 40 Canadian students would have received doctorates in Engineering from the University of Toronto. In comparison, the "top twenty" U.S. universities awarded 58 doctorates in Engineering to Canadian citizens in 2003-2004.<sup>11</sup> This is quite different from overall doctorate awards, discussed above, where the University of Toronto awarded twice as many doctorates to Canadians as the overall "top twenty" U.S. universities combined.

The over-representation of the "top twenty" U.S. engineering universities in doctorates in Engineering awarded to citizens of Korea and of the Republic of China may also be explained by the presence of a sufficient number of high quality doctoral programs in these countries to induce many students to "stay at home" unless they can study in the highest-ranked programs abroad. The Engineering "top 100" includes three universities in South Korea and two in the Republic of China.

The Engineering "top 100" also includes two universities in Hong Kong, and three in the People's Republic of China (excluding Hong Kong). In proportion to the number of

<sup>11</sup> Our estimate. Published data from the 2002-2003 SED-C demonstration project show that 13% of doctorates awarded at the University of Toronto in this year were in Engineering. The University of Toronto awards on the order of 550 doctorates each year.

Engineering doctorates awarded in the People's Republic of China, three to five high quality universities in Engineering may not be enough to accommodate students who would otherwise "stay at home".<sup>12</sup>

## Post-Graduation Plans

Doctorate in hand, the new graduate sets out on the career of a doctorate holder. Both the Canadian and U.S. Surveys of Earned Doctorates collect information on the initial steps of this career through questions on post-graduation plans. In the SED-C, 74% of 2003-2004 doctoral recipients had definite plans following their graduation.<sup>13</sup> Of these, 56% had definite employment and 44% had plans for further study or training. In the SED-US, 70% of 2003-2004 doctoral recipients had definite plans, 65% for employment and 35% for further study or training.

Table 7. Percentage of U.S. doctoral recipients in 2003-2004 with definite plans who plan on further study or training

Percentage of those with definite plans who plan on further study or training						
Life Sciences	Engineering	Physical Sciences	Social Sciences	Humanities	Other	All
67	36	56	31	12	6	35

Table 7 gives the percentage of doctoral recipients in the U.S. with definite plans whose plans were for further study or training. The table shows a high prevalence of post-doctoral training in the Life Sciences and Physical Sciences, a lower prevalence in Engineering and Social Sciences, and very little post-doctoral training in Humanities and the Other fields of study. Information on plans by field of study was not available for this paper from SED-C, but the overall pattern is not likely to be very different.

It is interesting to compare plans for post-doctoral study with the typical age at which the doctorate is received for fields of study. Table 8 gives the mean age at which the doctorate was received in universities in Canada and the U.S. in 2003-2004 by field of study. The mean ages in Canada and the U.S. are similar, with a somewhat younger mean age of receipt in natural sciences and engineering in Canada than in the U.S.

<sup>12</sup> If we apply Weiguo's and Zhaohui's figure 38% of total doctorates in Engineering to their total doctorates awarded in the People's Republic of China in 2003—18,806—we obtain an estimate of approximately 7,100 doctorates in Engineering. This is more than the total number of doctorates awarded in Engineering in the U.S. in 2003—5,619—but there are far fewer top-ranked programs in the People's Republic of China.

<sup>13</sup> Both surveys defined definite plans as plans to return to or continue in predoctoral employment or a contractual or definite commitment for other work or study. For SED-US, the percentage with definite plans is available by field of study. These percentages ranged from a low of 63% for Engineering to a high of 75% for Other (Education and Professional/Other). SED-US also gives the percentage with definite commitments by citizenship status: 72% for U.S. citizens, 63% for permanent residents and 66% for temporary visa holders.

The median age at which the doctorate is received is probably a better indicator of the "typical" age of receipt than the mean. This indicator is available for the U.S. and is also given in Table 8. Whichever indicator is used, the age at which the doctorate is received is higher in the Social Sciences, Humanities and Other fields of study than in Life Sciences, Engineering and Physical Sciences.

This is misleading, however, as to the age at which the doctoral recipient begins a work career, since Life Sciences and Physical Sciences are the fields of study where the highest percentage of doctoral recipients go on to post-doctoral training or study. Several years spent in post-doctoral study will mean that graduates in Life Sciences and Physical Sciences are likely to be as old as those in Social Sciences and Humanities by the time they begin a work career.

Table 8. Age at receipt of the doctorate by field of study from universities in Canada and the U.S., 2003-2004

Age at graduation	Life Sciences	Engineering	Physical Sciences	Social Sciences	Humanities	Other
Canada-mean	34	35	32	36	38	44
U.S.-mean	35	36	34	36	38	44
U.S.-median	32	31	31	33	35	41

### Sector of Employment

Table 9 shows the sector of employment for 2003-2004 doctoral recipients with definite employment commitments.<sup>14</sup> While the sectors are not strictly comparable for the two countries, certain common patterns emerge. The field of study with the highest percentage of private sector employment in both countries is Engineering, followed by Physical Sciences and Life Sciences. The percentage of private sector employment is low in Social Sciences, Humanities and the Other fields of study.<sup>15</sup> The educational sector is a major employer of PhD recipients in both countries. The ranking of fields of study by the percentage of doctoral recipients going to the education sector is the same in the two countries (assuming that other is predominantly primary and secondary education) except

<sup>14</sup> Unfortunately the sector structure in the available data was not the same in Canada and the U.S. Canada aggregated all of education services (education in the table); the U.S. includes elementary and secondary schools in the "other" category, where these and non-profit organizations are the main components. Canada distinguishes health and social services, which are likely to be split between the private sector, government and other in the U.S. Canada distinguishes various components of the private sector which we have recombined here.

<sup>15</sup> The high percentage of Social Science graduates in Health and Social Services in Canada is due to the fact that Psychology is the largest component of this field of study. Health and Social Services in Canada is predominantly outside the private sector.

for the difference in the ranking of the Life Sciences. Employment in the Humanities and in the Other fields of study is predominantly in education.<sup>16</sup>

Table 9. Sector of employment of 2003-2004 doctoral recipients from universities in Canada and the U.S. with definite employment commitments by field of study

	Life Sciences	Engineering	Physical Sciences	Social Sciences	Humanities	Other
Canada						
Education	39	37	44	51	79	84
Government	10	8	13	10	7	10
Health&Social	16	--	--	29	--	--
Private sector	35	48*	37*	6*	10*	5*
U.S.A.						
Academe	53	22	45	60	84	57
Other	9	5	5	15	10	33
Government	14	11	8	11	2	5
Industry/SE	24	62	42	14	4	6

\* At least one component of the private sector is missing due to suppression

### Location

Post-graduation plans include not only what to do, but where to do it. We now turn to the question of where doctoral recipients plan to live. Table 10 shows the location plans of citizen and non-citizen doctoral recipients in Canada and the U.S. The percentage who plan to stay in Canada are nearly identical for the two categories of Canadian citizens (citizens of Canada only and dual citizen) and are lower than the percentage of U.S. citizens who plan to stay in the U.S. Despite including permanent residents, the percentage of non-citizens who plan to stay in Canada is lower than the percentage of doctoral recipients on temporary visas who plan to stay in the U.S.

Table 10. Percentage remaining in country of receipt of doctorate by citizenship status for doctorate recipients in Canada and the U.S., 2003-2004

Canada			U.S.		
Citizen of Canada only	Dual Citizen	Not a Citizen	Citizen	Permanent Resident	Temporary Visa
83	82	61	92	94	69

Of those planning to leave Canada (citizens and non-citizens), 63% intend to go to the U.S. Another way of looking at plans to leave Canada is the following: 23% of doctoral recipients in Canada were temporary residents when they began their doctoral programs; 21% of Canadian doctoral recipients plan to leave Canada. Thus the migratory gain to Canada from doctoral education in Canada is very small.

<sup>16</sup> The Other field of study is for the most part doctorates in Education.

We now examine the location plans of foreign doctorate recipients in the U.S. in 2003-2004 by country of citizenship and ranking of university program. Table 11 gives the percentage of foreign students who plan to stay in the U.S. for the top five countries of foreign citizenship for graduates of the twenty highest-ranked universities in the U.S. and for graduates of all other U.S. universities. The differences within citizenships between the two groups of countries are not large, except for the Republic of China. The People's Republic of China and India have very high percentages of PhD recipients from U.S. universities who intend to stay in the U.S., but at least 60% of foreign graduates from all of the leading countries of citizenship (other than the Republic of China) plan to stay in the U.S.

Table 11. Percentage of foreign doctorate recipients from U.S. universities in 2003-2004 who plan to stay in the U.S. by selected citizenship, twenty highest-ranked U.S. universities and all other U.S. universities

Country of citizenship	Percentage who plan to stay in the U.S.	
	Top 20 universities	All other universities
People's Republic of China	92	94
Korea (RoK and DPRoK)	74	72
India	90	92
Republic of China	68	45
Canada	63	64

## Conclusion

Canada and the U.S. share a long border and have highly integrated, advanced economies. Both have large numbers of excellent universities, as shown by the rankings used in this paper. Canada's publicly funded universities compare favourably to U.S. publicly funded universities, although the top of the rankings is dominated by U.S. private universities. Most Canadian universities are English language universities.

The indicators developed in this paper show that Canadian and American citizens who receive doctorates have similar field of study distributions. Our computations show that a higher doctoral graduation rate for Canadian citizens than for U.S. citizens receive doctorates. On the other hand, total doctoral awards by U.S. universities are much higher, both relative to the total population and to the 30-34 year old age group. The difference is due to the much greater proportion of foreign students among U.S. doctorate recipients.

What explains the greater attractiveness of doctoral study in the U.S. than in Canada for students from outside North America? In part, no doubt, the fact that the world's highest ranked universities are in the U.S., but many foreign students complete doctorates at universities that are no more highly ranked than Canadian universities.

We would argue that for many foreign students, the greater attraction of the U.S. is due to better post-graduation work prospects. In our companion paper, we document a deterioration in labour market outcomes for PhDs in Canada, relative to the U.S., in the 1990s. Our argument, then, is that the decision to undertake doctoral studies abroad is, for many students a decision to work abroad as well, or at least a decision to have better prospects for working abroad after graduation. In this regard, it is worth noting that over 90% of doctoral recipients from India and the People's Republic of China plan to remain in the U.S. after their graduation, at least initially. While doctoral degree holders are quite mobile between Canada and the U.S. (as we document in the companion paper), there are surely advantages to already having a legal residency status in the U.S. and familiarity with the U.S. doctoral labour market.

Another striking fact that emerges from our indicators is the heavy concentration of non-North American PhD recipients in engineering, physical sciences and life sciences, relative to Canadian and U.S. citizens. The contrast is particularly striking for engineering, which produces less than a tenth of doctoral recipients among Canadian and U.S. citizens and more than a quarter of doctoral graduates who are not Canadian or U.S. citizens. Foreign citizens constitute 60% of engineering doctoral recipients from U.S. universities.

Many of these doctoral degree holders stay on in the U.S., at least initially following graduation. Both the U.S. and Canada have very high percentages of the foreign-born among their doctoral degree holders. A very large part of North American R&D and of North American innovation more broadly is due to the attractiveness of U.S. universities for doctoral study in the natural sciences and engineering and of the U.S. as a place to work following graduation.

Is this situation likely to continue? We would argue that our indicators furnish reasons to think that as incomes rise and universities develop in the Asian countries that are large sources of foreign doctoral students, citizens of these countries will increasingly tend to study and work in these countries. Although the number of countries is small, it is striking that in countries with higher income levels than the People's Republic of China and India, the percentage of doctoral graduates who plan to leave the U.S. after graduation is higher.

It is also the case that as the quality of available universities in a country increases, the concentration of PhD graduates from that country in the U.S. in the highest-ranked U.S. universities increases. We argue that this occurs because when high quality opportunities for doctoral studies are available "at home", they are usually preferred to study abroad, so that only those who are admitted to the highest ranked programs abroad leave the country. The implication is that as the number of places in high quality doctoral programs in a country increases, it will send fewer doctoral students abroad.

We would conclude then that it is likely to be increasingly difficult to recruit foreign students to undertake doctoral studies in North America and to stay on after their studies in the North American natural science and engineering workforce.

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